

## VII-16

## Characteristics of Water Quality and Pollutant Load Analysis in Chikugo River

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## 1. Introduction

Water is one of natural resources that is necessary to human life. Population growth and human activities increase water consumption and pollutant load to water bodies. Rivers are closely tied to human activities and this is one factor why rivers are mostly polluted. Water quality management plays an important role in maintaining good condition of water resources such as rivers, seas, etc. The characteristics of water quality of those river basins are important information, and should be collected before applying water quality management to any river basins. This study was carried out to research the characteristics of water quality and pollutant load of Chikugo River with applying GIS.

## 2. Chikugo river

Chikugo River is the longest river in Kyushu Island. The length excluded branch length is 143 km. Basin area is 2860 km<sup>2</sup>. Population of Chikugo River basin area is 1,064,000. Total annual precipitation is about 2000 mm. Around half amount of the total precipitation in year occurs in June-July. Average flow rate at downstream is 75 m<sup>3</sup>/s. Chikugo River flows into the Ariake Sea where fishery and laver production are active. Major water use of Chikugo River is both drinking water supply and agriculture. Chikugo River is important water resources of the watershed and also for the Ariake Sea's productivity because of nutrients transportation.

## 3. GIS data analysis

The application of GIS provided a lot of important information e.g. population, paddy field area, forest area, etc. The watershed of Chikugo River was divided into 10 parts and specified the points for water quality observation, as shown in Fig.1. The information of each part can be provided from GIS. Each information is accumulated in the river flow direction. Senoshita is the last down area point before Chikugo River flows into the Ariake Sea.

## 4. Yearly characteristics of water quality of Chikugo river

In this study, the observed data of water quality in 1986-1997 were used. The change of water quality of Chikugo River has seasonal pattern. In summer flow rate and BOD concentration are high and in winter flow rate and BOD concentration are low. On the drought year, 1994-1995, flow rate of Senoshita was very low and BOD concentration was very high as shown in Fig.2 and 3. In Fig.4, the relationship between BOD concentration and flow rate is shown with water temperature. In case of high temperature more than 20°C, BOD concentration decreases when flow rate increases. And in Senoshita there is Chikugo water gate which is controlled to be opened when the flow rate in Chikugo River exceeds the flood high water level. Eutrophication seemed to be occurred under this critical low flow rate. The increased BOD concentration is caused by concentration of algae. Therefore, DO and pH are very high in 1994 - 1995 as shown in Fig. 5. Nitrogen concentration of Chikugo River, characteristics of water quality, eutrophication

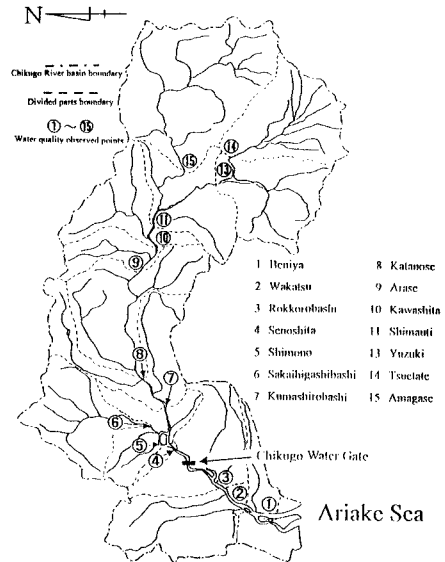


Fig. 1 Divided Chikugo River basin

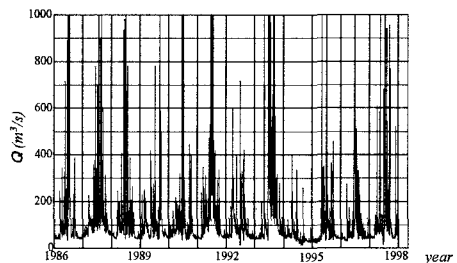


Fig.2 Flow rate of Chikugo River at Senoshita

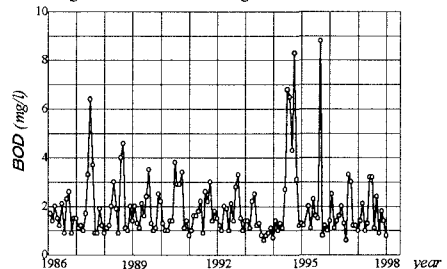


Fig.3 BOD concentration at Senoshita

Senoshita is shown in Fig.6. In winter T-N is about 1 mg/l while in summer is about 1.5 mg/l. Almost of nitrogen concentration is in  $\text{NO}_3\text{-N}$  form.  $\text{NH}_4\text{-N}$  concentration is less than about 0.2 mg/l. The concentration of T-N in Chikugo River was high in the middle period around June - August of almost every year. Behavior of T-P concentration in the middle period was same as the change of T-N concentration. This middle period is irrigation period for paddy field. Fertilization, carried out in this period, is one cause of high concentration of nitrogen and phosphorus of Chikugo River. Except Yuzuki and Amagase, the trends of T-N and T-P concentration of other parts in Chikugo river basin are also same with the behavior of Senoshita.

##### 5. Monthly characteristics of water quality of Chikugo river

After the yearly characteristics of water quality of Chikugo River were cleared, the water quality data were averaged in every month. Figure 7 shows the averaged monthly flow rate, COD concentration and COD loading of Chikugo River at Senoshita and Kumashirobashi. The differences of flow rate and COD concentration between both parts are not much high in winter because of pollutant load of miscellaneous wastewater, industry and other human activities that have no relationship with irrigation. The difference in COD loading is high especially in summer period when irrigation and fertilization have been carried out, because the paddy field area is very large between Kumashirobashi and Senoshita.

Water qualities of Chikugo River at Sakaihigashibashi are also shown in Fig.7 where COD concentration is very high. This period of high COD concentration appeared in summer which was caused by fertilization in irrigation period. On the other hand, the COD loading was very low due to low flow rate. Therefore this COD loading has no effect on the COD loading in Senoshita and down area of Sakaihigashibashi. Miscellaneous wastewater from households is one of pollutant load of COD loading. The discharge of this COD loading is almost constant in everyday and occurs all the year. To determine the amount of pollutant load caused by irrigation, the pollutant load caused by wastewater that is unrelated with irrigation should be separated from total pollutant load.

##### 6. Summary

From 12 years observed data, The characteristics of water quality of Chikugo River can be classified with high flow rate and high concentration of COD, T-N, T-P in summer which is irrigation period and low flow rate and low concentration of COD, T-N and T-P in winter, no irrigation period. In 1994-1995, eutrophication in stagnant area of Chikugo water gate was appeared in the period of low flow rate. Irrigation and fertilization in summer period cause high nutrient concentration which may accelerate the eutrophication in Chikugo River.

##### Acknowledgement

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##### Reference

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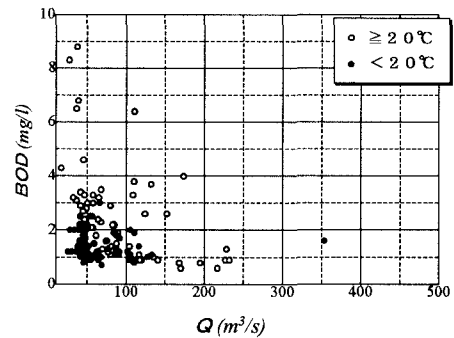


Fig.4 Relationship between BOD concentration and flow rate at Senoshita

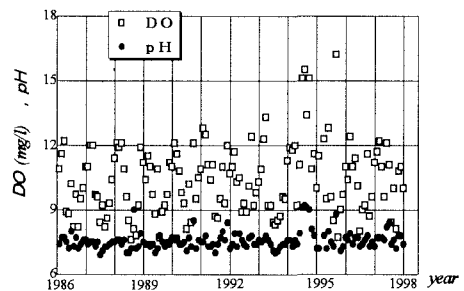


Fig.5 DO concentration and pH at Senoshita

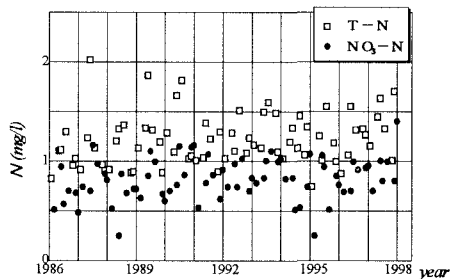


Fig.6 T-N and  $\text{NO}_3\text{-N}$  concentration at Senoshita

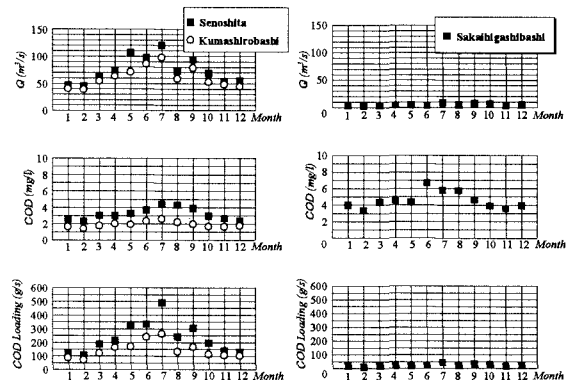


Fig.7 Averaged monthly water quality at Senoshita, Kumashirobashi, Sakaihigashibashi